Organic grassland: the foundation stone of organic livestock farming

DAVID YOUNIE
SAC, Craibstone Estate, Bucksburn, Aberdeen AB21 9YA

INTRODUCTION

In organic farming, the components of the whole farm system interact closely and grassland plays the central role in this intricate web, including the arable cropping phase. Grassland is important particularly in relation to nitrogen supply via its influence on N-fixation, soil organic matter, structure and biological activity and it also has a major role to play in restricting the build-up of arable weeds and soil-borne crop diseases in arable rotations. Ruminant livestock share this central role with grassland on most successful organic farms, and the success of the livestock enterprise is intimately tied up with the management and productivity of the grassland.

TEMPORARY AND PERMANENT GRASSLAND

Where regular ploughing is possible and the climate permits arable cropping, a rotational system of temporary grassland production is preferable to permanent grassland, for a number of reasons:

a) Ensures a high clover content can be maintained in swards.
b) Provides clean grass, uncontaminated with worm larvae, annually for young stock.
c) Minimises the build-up of, and provides an opportunity for control of, perennial grassland weeds such as docks.
d) Permits the exploitation by arable crops of soil fertility built up under the grass/clover ley.
e) Provides an opportunity to produce arable crops for sale and/or livestock feeding.

A ley grassland policy has the disadvantage of increased seed and establishment costs, but this is a cost the farmer has to pay for the advantages listed above. Another potential disadvantage is the increased risk of nitrogen leaching loss following ploughing up the ley, but this can be minimised by ploughing in late winter, for a spring crop, rather than ploughing in autumn. In addition, ploughing of the ley will occur only once during the rotation.

MANAGEMENT OBJECTIVES

Grassland management objectives on organic farms are not necessarily prioritised in the same order as on conventional farms. Whilst maximising herbage and livestock output per hectare may be the common overall aim, the restrictions of the organic standards in relation to plant nutrient inputs and routine veterinary treatment of livestock mean that strategies to maintain high animal health status and to maintain soil nutrient status are equally, if not more important, than maximising herbage output per hectare in the short-term. In fact, although many conventional farmers considering converting to organic farming are mostly concerned about maintaining herbage productivity, in systems with a high proportion of young stock such as calves and lambs, it may not be herbage production which forces a limit on stocking rate, but the risk of parasitic gastro-enteritis caused by worm invasion.

THE ROLE OF GRASSLAND MANAGEMENT IN ENHANCING LIVESTOCK HEALTH

Grassland management has a major influence on livestock health through
a) the quality and quantity of nutrition obtained from grassland, and
b) the potential adverse effects of worm invasion and bloat.

Worm control

The extent of worm larval challenge which a contaminated pasture presents to grazing animals will depend on:

a) The level of contamination in the sward at the start of the grazing period (e.g. in spring).
b) The level of egg deposition by grazing animals during the current grazing period.
c) The degree to which weather conditions favour the development of eggs and larvae during the current grazing period.

Young animals are more susceptible to lungworm and stomach worms than adult animals. Because of this, the build-up of pasture contamination is much faster when the sward is grazed by young, infected animals rather than mature animals. As animals mature, they develop an immunity to the parasites on exposure to low or moderate levels of parasite challenge. However, mature animals may lose their immunity during periods of stress e.g. ewes during lambing which may excrete large numbers of stomach worm eggs - the peri-parturient egg rise.

Potential for worm control by grazing management

A number of grassland management strategies can be employed in order to minimise the risk of infection by endoparasites in cattle and sheep. These include:

Mechanism	Practice	Comment
Dilution	Lower stocking rates Mixed species grazing Mixed age groups grazing	Worm challenge on susceptible grazing animals is **diluted** by a lower stocking rate or by the presence of another (immune) species or (immune) adult stock of the same species see below
Evasion	Clean pastures ready before the expected rise in pasture infectivity i.e. late June (sheep) or mid July (cattle) Swards grazed by another species in spring Use of silage or hay aftermaths Use of new grass reseeds Use of annual forage crops	Worm challenge on susceptible grazing animals is evaded by **moving** animals from **contaminated pastures** to clean pastures (not grazed same year by the same species)
Prevention	Use of new grass reseeds Use of silage or hay aftermaths Use of annual forage crops Late lambing (*Nematodirus*) Yearly alternation between livestock species	Worm challenge is prevented by introducing **uninfected stock** to clean pastures every year

The yearly alternating clean grazing system is perhaps the most widely recognised clean grazing system. In this system, each field is managed according to the following three year rotation:

Year 1 ➔	Year 2 ➔	Year 3 ➔
Sheep	Silage	Cattle

The system can be refined further, for example, by moving weaned lambs in late summer to silage aftermaths, or moving some cattle in late summer to graze together with dry ewes after weaning. This system is only possible where each field is sufficiently flat for cutting for hay or silage. However, even where cutting is not possible, e.g. on undulating permanent pasture, a two-year rotation between cattle and sheep will also help to minimise the worm challenge.

The strategy adopted on any one farm will depend on the physical resources of the farm and on the farming system employed. However, worm problems will be minimised on farms which are able to employ:

a) a mixed ley/arable system
b) based on temporary leys rather than permanent grassland
c) with more than one livestock species
d) has land quality which allows silage to be made on every field.

Where physical and financial resources permit, organic livestock farmers should adopt such a system, or at least as many elements of it as possible, in order to minimise worm problems in young stock. The availability of new reseeds each year will provide a source of clean pasture in spring for grazing susceptible young stock. If silage can be made from all fields and arable crops can be grown, there is maximum flexibility to move susceptible young stock as the season progresses, to silage aftermaths or arable cropping fields in late season, and so evade the build-up in worm challenge. With more than one livestock species on the farm, the overall stocking rate of susceptible animals is reduced and options for mixed species grazing or yearly alternating grazing are available.
Some farm types may have very restricted options because of the limited physical resources of the farm. An example is the sheep-only farm on marginal land which may have limited land suitable for ploughing or grass conservation (and is therefore not suitable for a cattle enterprise). On such a farm it is difficult to adopt a clean grazing system. The only grassland management option may be to restrict stocking rate of sheep, although this may have consequences in terms of poor utilisation of herbage and a

subsequent drop in forage quality. In this situation the farmer also needs to introduce a system of regular faecal egg counts in order to predict when a rise in worm infection is about to occur and hence when anthelmintic treatment is necessary, although frequent necessity for anthelmintic treatment will not be acceptable to the organic certification body. Introduction of a breeding programme to improve worm resistance in the sheep stock will also be necessary in this situation.

Herbage quality and livestock health

The trace element (TE) content of the herbage is largely determined by the parent material of the soil. Nevertheless, management decisions can affect trace element content. In particular, a high soil pH will reduce the uptake of trace elements in the herbage. A pH of 5.8 to 6.0 should be the target pH, therefore, rather than pH 6.2 to 6.5. Given that there is a limited supply of trace elements in the soil, the higher the yield of the crop, by dilution the lower will be the TE content of the herbage in percentage terms. Thus perennial ryegrass, which is relatively high yielding, tends to have a lower copper content than many other species. Herbage species which have a deeper root system may have a high TE content. A number of herb species have deep tap roots and have the potential to explore deeper soil layers than conventional herbage species, and potentally make available an enhanced supply of nutrients (Swift *et al.*, 1990; Wilman and Derrick, 1994). This potential advantage of herbs has been demonstrated in practice, in the animal, by Younie *et al.* (1997), with weaned lambs grazing pure stands of chicory or perennial ryegrass (Table 1).

Table 1. The effect of grazing pure stands of chicory (C) or perennial ryegrass without (PRG) or with a Cosecure+ bolus (PRG/CS), on the blood mineral status of grazing lambs (from Younie *et al.*, 1997).

Blood constituent	C	PRG	PRG/CS	Level of sig.
Ca (mmol/l)	3.15	3.01	3.16	*
PO_4 (mmol/l)	2.64	2.43	2.38	NS
Na (mmol/l)	144.3	137.5	141.6	NS
Mg (mmol/l)	0.99	0.91	0.98	*
Cu (μmol/l)	10.25	7.55	11.49	*
GSHPx (units/ml RBC)	19.38	17.38	20.0	NS
VitB_{12} (ng/l)	965	705	929	***

+ Administered orally as a sustained-release intra-ruminal source of supplementary Co, Se and Cu.

- = P<0.05; *** = P<0.01

Deficiencies of calcium and magnesium in the diet (potentially causing milk fever and hypomagnaesemia) are not normally as serious in the organic situation as in the conventional situation. This is because the phenomenon of luxury uptake of K in herbage is less likely to occur since spring applications of N and K fertilisers/manures are not usually made to grazed grass. Nevertheless, the risk should be borne in mind, especially if spring slurry applications are made to grazed grass on a clay soil (which will have an inherently high K availability).

In organic ruminant diets, grassland is the primary source of protein as well as energy. Because of the restricted choice of purchased protein sources, it is essential to maximise the amount of home-produced protein. Thus, there is a nutritional need to maximise clover content in swards, as well as an agronomic need (see below). The crude protein (CP) content of silage will vary with the clover content and the cutting date. Early cut pure clover swards can have CP contents in excess of 20% of the dry matter (DM), while late cut swards with moderate clover content may be as low as 12 to 13% CP. In mixed grass/white clover swards, the proportion of clover in the DM in a first cut silage crop increases to a maximum around the second or third week of May and thereafter declines as the grass component starts to flower (Younie and Giordano, 1993). Thus, in the UK the second or third week of May is probably the best date to cut if a high digestibility, high CP silage is the aim, therefore.

In late summer, the white clover content of grazed pasture can be as high as 60 to 70% in the DM and soil nitrate N content is high. This leads to an excess of rumen degradable protein (RDP) in grazing animals. Much of this passes through the animal as urine and increases the risk of loss of N to the environment via ammonia volatilisation and nitrate leaching. In addition the excess of protein over energy in the diet can lead to health problems in productive animals such as high yielding dairy cows. In these situations the high protein intake should be balanced by buffer feeding a high energy forage such as whole crop cereal silage (Van Eekeren, 2000).

Bloat

Bloat will occur in cattle (but almost never in sheep) which are grazing rank (10 to 20cm) swards with a very high clover content. The risk of bloat is greatest in August and September, when clover content of swards is highest. Silage and hay aftermaths pose the highest risk, especially when coupled with low DM herbage, e.g. on damp, dewy mornings in September. Bloat rarely occurs in early summer. The occurrence of bloat can be predicted to some extent, therefore, and steps taken to minimise the risk. Cattle should never be turned on to rank clovery swards. They should be turned on to aftermaths immediately after the crop has been lifted, so that the clover grows to the cattle. If it is impossible to avoid turning cattle on to high risk swards, they should be well fed before transfer, on a dry afternoon, when the herbage is also dry. In very high risk situations, poloxalene bloat preventative should be fed for two days prior to transfer and for as long afterwards as the high risk period lasts.

ENHANCING HERBAGE PRODUCTION

The main factors affecting herbage production per hectare are:

a) botanical composition of the sward, and

b) growing conditions: nutrient supply and environmental conditions (soil moisture supply and temperature).

The farmer can do little about rainfall and temperature, but can have a major influence on the nutrient supply to and botanical compostion of the sward.

Botanical composition: seed mixtures

Nitrogen is the most important crop nutrient and so herbage legumes such as clovers are the driving force in organic systems, because of their ability to fix large amounts of atmospheric nitrogen. The quantity of N fixed is directly dependent on the proportion of clover in the sward. Thus, a major objective should be to **maximise the clover content** of the sward.

White clover is by far **the most appropriate and widely used forage legume** for organic farming systems in temperate maritime climates, because of its adaptability to a range of management and soil fertility conditions. It is persistent, is not demanding in terms of soil pH and drainage conditions, and can be used for management regimes ranging from continuous sheep grazing (for which small-leaved varieties are most suitable) to lax defoliation, including cutting (for which larger leaved varieties are most suitable).

Red clover is also undemanding in terms of soil conditions and is highly productive, but is not persistent nor well-suited to grazing, and should only be sown in mixtures intended for short-term leys (up to three years), primarily for cutting. It is probably the best species for use as a one or two year green manure. Lucerne and sainfoin also have considerable potential as crops for conservation, but are suitable only for soils with a relatively high pH (above 7) and, in the case of lucerne, good drainage.

The agronomic characteristics of the companion grass species are also important in enhancing sward productivity. Although **perennial ryegrass** has been criticised as being more appropriate for intensive high N systems than for organic or low-input systems, it is **undoubtedly the most suitable species for ley farming in temperate maritime conditions**, given its ease of establishment, yield potential, persistence, and quality characteristics. Tetraploid varieties are known to promote a higher clover content in the sward than diploid varieties, because of their more open growth habit.

Traditionally, organic farmers have often regarded secondary or indigenous grass species and forbs with approval, either in unsown pastures and field boundaries or sown in complex seed mixtures. Improved livestock nutrition and health are the reasons normally given. Herbs also tend to be more drought resistant than grasses and their tap root systems may also lead to a more open soil structure. Despite these potential advantages, forage herbs have been largely overlooked in practice, even in organic farming (Foster, 1988). This is changing to some extent, at least in New Zealand and Australia, where breeding effort has led to the commercial release of varieties of **chicory** and **ribwort** (Moloney and Milne, 1993).

Perhaps the main reason for the low level of use of forage herbs is their generally low contribution to sward biomass, largely resulting from low seed rates, poor establishment and persistence. This may be due, at least in part, to their inability to persist under intensive management regimes involving frequent utilisation by cutting and grazing - regimes to which vigorously tillered grass species such as perennial ryegrass are ideally suited. New thinking is also required in relation to the most appropriate companion species and mixtures for forage herbs. Umrani (1998) has shown that perennial ryegrass, with its vigorous, densely tillered growth habit, is a major competitor. It significantly reduced root length, root weight and shoot weight of individual herb plants. The upright and less well tillered growth habit of timothy is less competitive and, coupled with the N-fixing ability of white clover, makes for a more suitable mixture, perhaps **sown in strips** or as separate swards, with the main bulk of the field sown to a ryegrass-based mixture. Of course the composition of mixtures needs to be designed with the proposed management regime in mind, and much work requires to be done to develop reliable and persistent herb-based mixtures for a range of organic management situations.

Some typical seed mixtures for organic grassland are shown in Table 2.

Table 2. Typical seed mixtures for organic leys (kg/ha)

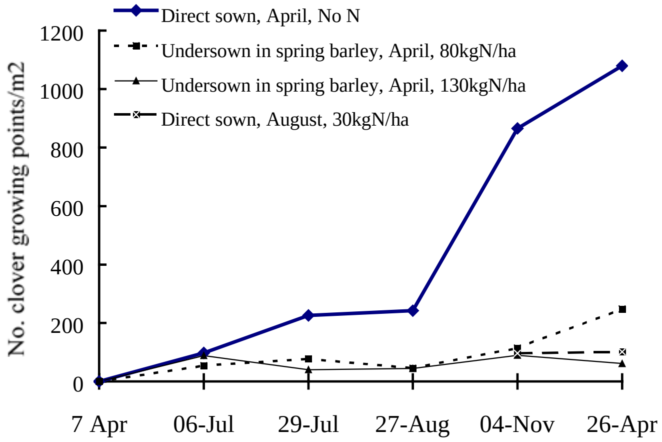
	Two-year ley, two cuts silage, aftermath grazing	4 to 6 year ley, cutting, grazing	Long-term ley, mainly grazing
Hybrid ryegrass (T)	5		
Intermediate perennial ryegrass (T)	10	10	
Late perennial ryegrass (T)		14	28
Timothy		4	
Red clover	10		
Small-leaved white clover		1.0	
Medium-leaved white clover		1.5	1.5
Large-leaved white clover		1.5	2.5
Total	25	32	32

T = Tetraploid.

Botanical composition: Clover establishment

Given that clover is the most important component of the sward, the primary objective in establishing the sward must be to achieve rapid and effective establishment of the clover. For both white and red clovers, the best method of establishment is by direct sowing (i.e. without a cover crop), in spring, on a ploughed seedbed (Figure 1). In comparison, undersowing with a cereal delays the development of both clover and grass plants, although it can still give satisfactory establishment since second or third organic cereal crops are not always vigorous, competitive crops. Generally the most unreliable method of clover establishment is sowing in late summer/autumn, because of the risk of loss by frost heave of poorly rooted and anchored clover seedlings during winter. Clearly, this risk is worst in areas where growing seasons are short and winters are severe.

Figure 1. Effect of undersowing, date of sowing and N supply on establishment of clover (Younie *et al.*, 1984)



In some situations, at least during conversion, there may be a need to **oversow clover** into existing swards in order to improve clover content, rather than to undertake a complete reseed. This situation is sub-optimal for the germinating clover seedling: sown on the surface, surrounded by very competitive, well established plants. The type of machine which is used to deliver the seed is largely irrelevant - the two most important factors in successful oversowing are:

a) an adequate soil moisture supply, and
b) control of the competition from the existing sward.

These requirements are best met by broadcasting the seed in early spring when there is still plenty of moisture in the soil into a very short, well-grazed sward, and to continue grazing right through the first season to control the competition.

Botanical composition: Maintenance of clover content

The four factors which have greatest influence on white clover content in an established sward are:

a) Soil nutrient content, in particular pH, phosphorus (P) and potassium (K) content;
b) avoidance of application of soluble N;

c) autumn or winter grazing to encourage clover content;
d) cutting for hay or silage in mid-season to increase stolon density.

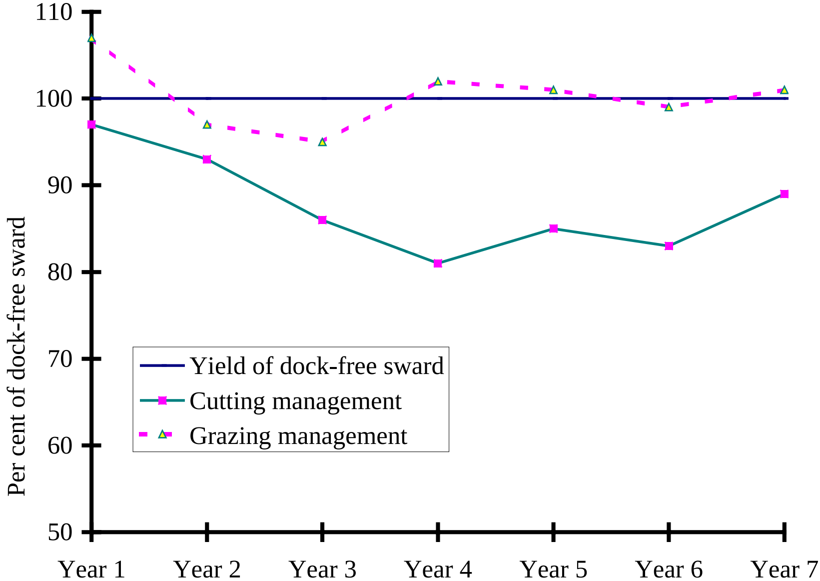
Application of soluble N is not a major issue in the organic situation, and it will not be possible to cut every sward in mid-season. However, it is vital that organic farmers maintain soil pH, P and K levels, and that swards are grazed down hard, ideally by November/December. This removes grass cover, allows light in to the light receptors on clover stolons, and encourages subsequent stolon branching (Laidlaw *et al.*, 1992).

Red clover grows from a crown in an upright, tufted growth habit. It does not have the same powers of recovery and recolonisation as a stoloniferous species such as white clover. Inevitably, therefore, the plant density of red clover and the sward productivity will decline after the first year. The major factors which are implicated in loss of red clover plants are stem eelworm and fungal invasion of the crown (e.g. by *Fusarium*) brought on by physical damage to plants by grazing animals, especially sheep, and passage of vehicles. It follows, therefore, that persistence of a satisfactory stand of red clover is more likely to be achieved by selecting varieties which have a high resistance to eelworm, by avoiding overgrazing by sheep, and by minimising the passage of vehicles on the sward.

Botanical composition: weed control

Control of perennial weeds such as dock and creeping thistle presents a major agronomic challenge in long-term organic grassland, since herbicide use is prohibited. A combination of different approaches is likely to be required. Where the site is ploughable, adoption of a ley/arable system using, say, 3 to 5 year leys rather than permanent grassland, is likely to prevent the problem developing because of the regular ploughing and disturbance to dock plants. Continuous cutting for hay or silage should be avoided if possible because a dock infestation becomes worse (and grass yield falls) more rapidly under a cutting than under a grazing management (Figure 2).

Figure 2. Change in relative yield of dock-infested swards over time, under cutting or grazing management. (Initial dock density two plants/m^2) (Extracted from Courteny, 1985)


110
100
90
80
70
60
50
Per cent of dock-free sward
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Yield of dock-free sward
Cutting management
Grazing management

Regular topping of grazed swards, and soil aeration to improve grass growth and cause physical damage to dock roots, may also limit the increase in dock density (Hopkins *et al.*, 1997). When dock infested grassland is to be reseeded, rotovating the turf to a depth of 8 to 10cm in June, followed by dessication for 8 to 10 weeks before ploughing and establishment of the next crop, has been successful (Welsh, 1995). Perhaps a more active degree of dock tap root destruction and continued surface disturbance would be achieved by grazing with unringed sows. Certainly this is one of the main attractions of an organic pig enterprise.

As implied above, it would be preferable to introduce an intermediate arable crop or winter cover crop before reseeding the grass sward. The additional cultivation involved is likely to reduce dock density further, provided that ploughing and not surface cultivation is used for the establishment of the intermediary crops, since surface cultivation generally leads to more weed germination than ploughing. Forage rye may be a suitable winter cover crop in this scenario, since it is reputed to have allelopathic effects. When the new sward is eventually resown, Hopkins *et al* (1997) have suggested that high grass/clover seed rates can reduce dock infestation at sward establishment.

Crop nutrient supply: Nitrogen

As indicated above, N is the single most important nutrient for most crops, including grassland. The ultimate source in organic systems is biological N fixation, and the amount generated is directly dependent on the clover content of the sward.

Whitehead (1995) reported amounts of fixed N ranging from 0 to 445 kgN/ha/ann, with an overall average of 152 kgN/ha/ann. The lower end of this range is associated with soils of high potential for N mineralisation, continuous grazing management and smaller leaved white clovers, whilst the upper end of the range is associated with soils of low potential for N mineralisation, cutting or rotational grazing management, large-leaved white clovers and red clover or lucerne (e.g. Davies and Hopkins, 1996).

The level of N fixation is primarily dependent on the clover content of the sward, particularly in the early years of a ley (e.g. Van der Meer and Baan Hofman, 1989). Kristensen *et al* (1995) have used clover ground cover as the basis for estimating the amount of atmospheric N fixed in grass-clover systems (Table 3).

Table 3 Effect of clover content and age of ley on estimated N-fixation in organic grass-clover leys (kg N/ha/ann) (from Kristensen *et al*, 1995).

Clover content (% ground cover)		10-29	30-49	Above 49
Clover content (% in dry matter)		3-16	17-29	Above 29
Age of ley (years):	1st, 2nd	80	157	248
	3rd, 4th and 5th	47	84	128

In addition to contributing to herbage growth, a proportion of the atmospherically fixed N is stored in roots and stubble or is immobilised in soil organic matter, i.e. it contributes to the longer term build up of soil organic matter and soil N status. Simultaneously, a proportion of the N in the soil organic pool is mineralised and becomes available for uptake by pasture plants. As the supply of N from mineralised soil organic matter increases (e.g. in the later years of a ley), the relative contribution from N-fixation to the overall supply of N to the sward declines (Younie, 1992; Davies and Hopkins, 1996), as implied also in the data of Kristensen *et al* (1995) in Table 3.

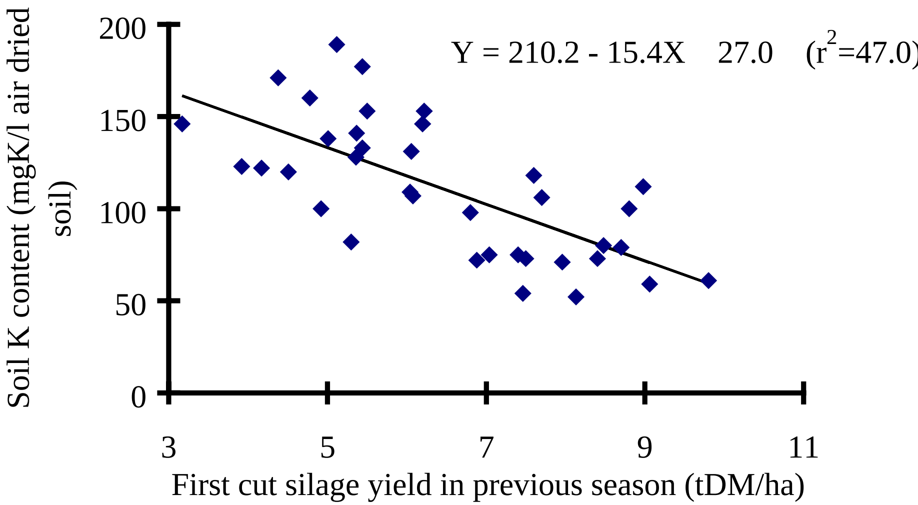
The farmer can also optimise the amount of mineralised soil N by avoiding soil compaction by grazing animals and by machinery (e.g. manure application and silage harvesting machinery). Compaction can reduce mineralisation of N by 30% (Hansen, 1995). Avoidance and alleviation of compaction (e.g. by regular sub-soiling) are an important means of improving N supply to the grass sward particularly on naturally poor-draining soils.

Crop nutrient supply: Phosphorus and potassium

One of the major aims of organic farming is to minimise the use of non-renewable resources. It follows, therefore, that soil nutrient status must be maintained as far as possible through management means and by efficient nutrient cycling within the farm, rather than relying on imported mineral fertiliser. In grassland, the main priority concerns the removal of nutrients from fields cut for hay or silage. With a yield of 10 tDM/ha/ann, nutrient offtake in the herbage will be in the region of 80 kgP_2O_5/ha/ann and 260 kgK_2O/ha/ann (Fowler *et al.*, 1993; Younie *et al.*, 1998). This can obviously have a major effect on soil K and P content and consequently on herbage and crop yield.

Figure 3 shows the adverse effect which high yields of first cut silage can have on exchangeable soil K content in just one season, in grass-white clover swards in an organic crop rotations trial on a sandy loam soil in NE Scotland (10% clay). The relationship is significant at the $P<0.001$ level.

Figure 3. Effect of first cut silage yield in previous season on soil K status on a sandy loam soil in NE Scotland (from Younie and Baars, 1997).



Similarly, on a sandy soil in the Netherlands, Younie and Baars (1997) reported reductions of 62% and 39% in soil K content over three years in, respectively, cut and cut/grazed organic grass/clover leys yielding 9 to 11 tDM/ha. In contrast, on similarly managed swards on clay soils, no decline in soil K content was detected. Clovers are poor competitors for soil P and K compared to grass. The reductions in K content in the experiments of Baars described above caused a significant loss of clover from the swards. This adverse effect of low soil K content on clover content will restrict the input of atmospherically fixed N in the system and have a knock-on effect on herbage yield.

Manurial strategy

The manurial strategy needs to have a combination of rotational and annual approaches. It is important to have a long-term or rotational perspective since the farmer relies, to a large extent, on release of N, P and K from soil reserves. Changes in soil nutrient status should be monitored regularly, therefore; say every 3 to 4 years. Lime is permitted if pH falls to undesirable levels. Deficiencies in soil P and K can be met from imports of approved, composted or aerated non-organic manures or from approved mineral fertilisers. Rock phosphate can be used to overcome P deficiency, but is not immediately effective so the farmer must anticipate requirements 2 to 3 years in advance. Approval for use of mineral potassium sources (e.g. potassium sulphate or sylvinite) must be sought before use.

On an annual basis, it is essential that manure storage facilities are effective, so that nutrient losses from the system can be minimised. Organic grass-clover swards intended for conservation must be given the highest priority in the distribution of manures, particularly on sandy soils. A separate application of manure should be applied for each cut, starting in late January/February for the first cut. Ideally, management of any one field should **alternate annually between cutting and grazing** rather than continuous cutting, in order to minimise nutrient offtake. In contrast, no manure application is necessary for grass for grazing. In practice, application rates of farmyard manure (FYM) or slurry will be determined by the quantity available, but a possible annual manurial strategy could be as follows:

Source of:	Application rates

	N	P, K	1st cut	2nd, 3rd cuts
Grazing	Clover, Soil N	Recycled, Soil P, K	N/A	N/A
Cutting	Clover, Soil N	FYM, slurry, Soil P, K	FYM: 20t/ha, or Slurry: 22,500 l/ha	FYM: 20t/ha or Slurry: 22,500 l/ha

POTENTIAL LEVELS OF HERBAGE YIELD AND LIVESTOCK OUTPUT

Satisfactory annual yields and first cut silage yields are obtainable in clover-based organic systems provided a good legume content in the sward can be maintained and assuming satisfactory levels of soil P, K and pH status and soil moisture supply (Table 4).

Table 4. Reported levels of herbage production from organic grassland

Reference	Sward type	Herbage production (tDM/ha)			Stocking rate
		Annual (grazing)	Annual (mainly cut)	1st cut silage	(LU[5] per forage ha)
Baars & Veltman (i) (2000)	G/WC[1]/RC[2]		12.6	4.5	
Baars & Veltman (ii) (2000)	G/WC/RC		12.3	4.7	
Baars (2000)	G/WC		10.5		
Fowler *et al*. (1993)	G/WC[1]	10.1	10.1		1.6
Halberg & Kristensen (1997)	Varied	8.2/7.0[6]			1.6
Houghton & Poole (1990)	Unspecified				1.6
Jones *et al*. (i) (1996)	G/WC	7.2		4.2	1.7
Jones *et al.* (ii) (1996)	G/WC	7.1	8.8		1.6
Jones *et al.* (iii) (1996)	G/RC[2]		14		
Lampkin & Measures (1999)	Unspecified				1.7
Newton & Stopes (1995)	G/WC		13.0[4]		
Philipps (2000)	G/WC		12.5[4]		
Redman (1991)	Unspecified				1.8
Van d. Meer & B. Hofmann (1989)	G/WC	6.4			1.9
Van d. Meer & B. Hofmann (1989)	G/RC, L[3]		10.9		
Younie & Wightman (1992)	G/WC	8.7	8.9	5.9	2.1
Younie (1997)	G/WC		7.6	5.4	1.2
Younie *et al*. (1996)	G/WC		8.0	5.5	

[1] Grass-white clover, [2] Grass-red clover, [3] Lucerne, [4] Cut to ground level
[5] LU: One Livestock Unit = One Freisian cow producing 6000 litres per annum [6]Calculated as SFU * 1.35.

The herbage yields shown in Table 4 generally reflect the conditions under which the swards were monitored, namely site quality, legume species, cutting date or regrowth interval. For example, the first cut silage yields of 4 to 5tDM/ha (**mean 4.5tDM/ha**) were from cuts taken in mid-May, whilst the yields of 5 to 6 tDM/ha (**mean 5.6tDM/ha**) were from cuts taken in mid-June. The mean annual yield from swards which were mainly cut was **10.8tDM/ha**.

Spring growth in an unfertilised clover sward is lower than in a fertilised sward. In the systems comparison reported by Younie and Wightman (1992), mean herbage biomass in the organic sward at turnout in early May was 738 kgDM/ha, almost exactly half that of the fertilised control. Where spring growth is particularly important, e.g. with lambing ewes, it is vital that planning for spring grazing begins in the previous autumn. The sward should be grazed down hard in November/December in order to encourage clover content, but stock should be removed no later than late December, and no further winter grazing should take place until turnout in spring.

The mean of the stocking rates in Table 4 is **1.68 livestock units per forage hectare**. These figures take account of the grass required for winter keep. It is clear that, where the soil type is satisfactory and clover content is high enough, a stocking rate of 1.6 LU/ha/annum is feasible in practice. This will be more than adequate for most UK farmers, given that many will be aiming for a stocking rate below this level, in order to claim Extensification Scheme subsidy payment.

REFERENCES

Baars, T. (2000) Effective use of manure and fertiliser in organically grown grass/clover swards. In Soegaard K., Ohlsson C., Sehested J., Hutchings N. J., Kristensen T., (eds.) *Grassland Farming: Balancing environmental and economic demands*, Proc. 18th General Meeting of European Grassland Federation, 524-526.

Baars, T. & Veltman, L. (2000) Adapted grass/clover mixtures for ley farming - a participatory approach to develop organic farming systems. In Soegaard K., Ohlsson C., Sehested J., Hutchings N. J., Kristensen T., (eds.) *Grassland Farming: Balancing environmental and economic* *demands*, Proc. 18th General Meeting of European Grassland Federation, 542-544.

Courtney A.D. (1985) Impact and control of docks in grassland. In Brockman J.S. (ed) *Weeds, Pests and Diseases of Grassland and Herbage Legumes*. Occasional Symposium No. 18, British Grassland Society; British Crop Protection Council Monograph No. 29, 120-127.

Davies D.A. & Hopkins A. (1996) Production benefits of legumes in grassland. In Younie D. (ed) *Legumes in Sustainable Farming Systems*, Occasional Symposium, No. 30, British Grassland Society, Reading, 234-246.

Foster L. (1988). Herbs in pastures. Development and research in Britain, 1850-1984. *Biological Agriculture and Horticulture*, **5**, 97-133.

Fowler S. M., Watson C. A. & Wilman D (1993). N, P and K on organic farms: herbage and cereal production, purchases and sales. *Journal of Agricultural Science*, Cambridge, **120**, 353-360.

Halberg N. and Kristensen, I.S. (1997). Expected Crop Yield Loss When Converting to Organic Dairy Farming in Denmark. Biological Agriculture and Horticulture, 1997, Vol. 14, pp. 25-41.

Hansen, S. (1995) Effects of manure treatment and soil compaction on plant production of a dairy farm system converting to organic farming practice. *Agriculture, Ecosystems and Environment*, **56** (3), 173-186.

Hopkins A., Jones E.L, Bowling P.J., & Johnson R.H. (1997) Cultural methods of dock control in permanent pasture. *Fifth Research Conference, British Grassland Society*, September 1997, 39-40.

Houghton M. & Poole A.H. (1990) *Organic Milk Production*. Genus Information Unit Report No. 70, 31pp.

Jones E.L., Bowling P.J. & Haggar R.J. (1996) Forage yields and quality during conversion. In: Haggar R.J. & Padel S. (eds) *Conversion to Organic Milk Production*. Institute of Grassland and Environmental Research Technical Review No. 4, 57-65.

Kristensen E.S., Høgh-Jensen H. & Kristensen I.S. (1995). A simple model for estimation of atmospherically-derived nitrogen in grass-clover systems. *Biological Agriculture and Horticulture*, 12, 263-276.

Laidlaw, A.S., Teuber, N.G. & Withers, J.A. (1992) Out-of-season management of grass/clover swards to manipulate clover content. *Grass and Forage Science*, 47, 220-229.

Lampkin, N. and Measures, M. (1999) *Organic Farm Management Handbook, 3rd Edition*. University of Wales, Aberystwyth and Elm Farm Research Centre, 163pp.

Moloney S.C. and Milne G.D. (1993). Establishment and management of Grasslands Puna chicory used as a specialist, high quality forage herb. *Proceedings of the New Zealand Grassland Association*, **55**, 113-118.

Newton J & Stopes C (1995). Grassland productivity on organic farms, 1992-1994. *Elm Farm Research Centre Bulletin*, No. 18, 2-6.

Philipps, L. (2000) Achievable levels of production for organic grassland. In Soegaard K., Ohlsson C., Sehested J., Hutchings N. J., Kristensen T., (eds.) *Grassland Farming: Balancing environmental and economic demands*, Proc. 18th General Meeting of European Grassland Federation, 548-551.

Redman M. (1991) Organic dairy costings: Update. *New Farmer and Grower*, **33**, 20-21

Swift G., Davies D.H.K., Tiley G.E.D. & Younie D (1990) The nutritive value of broad-leaved weeds and forage herbs in grassland. *Scottish Agricultural College, Technical Note No.223.*

Umrani A.P. (1998) *Sustainable approaches for rangeland management and livestock production in Pakistan*. PhD Thesis, University of Aberdeen.

Van der Meer H.G. & Baan Hofman T. (1989). Contribution of legumes to yield and nitrogen economy of leys on a biodynamic farm. In Plancquaert P. & Haggar R.J. (eds) *Legumes in Farming Systems*, Developments in Plant and Soil Science, **37**, 25-36.

Van Eekeren, N. (2000) Balancing summer rations of dairy cows by means of urea content in bulk tank milk. In Soegaard K., Ohlsson C., Sehested J., Hutchings N. J., Kristensen T., (eds.) *Grassland Farming: Balancing environmental and economic demands*, Proc. 18th General Meeting of European Grassland Federation, 555-557.

Welsh J.P. (1995) Dock control demonstration trial. *Elm Farm Research Centre Bulletin*, 18, 6-7.

Whitehead, D.C. (1995). *Grassland Nitrogen*. CAB International, Wallingford, 397pp.

Wilman D. & Derrick R.W. (1994) Concentration and availability to sheep of N, P, K, Ca, Mg and Na in chickweed, dandelion, dock, ribwort and spurrey, compared with perennial ryegrass. *Journal of Agricultural Science, Cambridge*, **122**, 217-223.

Younie D. (1992). Potential output from forage legumes in organic systems. In Peeters A & Van Bol V. (eds) *Potential and limits of organic farming*, Proceedings of an EC Workshop, Louvain-la-Neuve, Belgium, September 1992, 116-129.

Younie D. (1997) Organic Beef and Sheep Systems. Paper presented at 'Grass is Greener' *British Grassland Society Winter Meeting 1997*. Great Malvern, November 1997.

Younie D. & Baars T. (1997). Resource Use in Organic Grassland: The Central Bank and the Art Gallery of Organic Farming. In Isart J. & Llerena J. (eds) *Resource Use in Organic Farming*, Proceedings of Third Workshop of European Network for Scientific Co-ordination in Organic Farming (ENOF), University of Ancona, Italy, 43-60.

Younie, D. and Giordano, A. (1993).Pattern of crop development in fertilised and unfertilised grass/clover swards grown for silage. *White Clover in Europe: State of the Art*, FAO REUR Series 29 (Ed J. Frame), 63-65.

Younie D. & Wightman P.S. (1992) Herbage production over eight years from clover-based and intensively fertilised swards under grazing and silage management. *Proc. Third Research Meeting, British Grassland Society*, September 1992.

Younie D., Watson, C.A. & Squire, G. (1996). A comparison of crop rotations in organic farming: agronomic performance. In Clarke J.H., Davies D.H.K., Dampney P.M.R., Froud-Williams R.J., Griffith P.J., Lane A., Sim L. & Stevens D.B. (eds) *Rotations and Cropping Systems.* Aspects of Applied Biology, 47, AAB, 379-382

Younie, D., Wilson, J.F., Carr, G. & Watt, C.W. (1984) The effect of undersowing, nitrogen application and date of sowing on white clover establishment. In Thomson, D.J. (ed.) *Forage Legumes*, Occasional Symposium No. 16, British Grassland Society, Reading, 182-183.

Younie, D., Umrani, A.P., Gray, D. and Coutts, M. (1997). Influence of chicory or ryegrass diets on trace element status of lambs. RASE Conference: '*Organic Farming - Science into Practice*'. RASE, NAC, Stoneleigh, November 1997.

Younie D., Wilson J.F., Reid C. & Wightman, P.S. (1998). Maintenance of soil potassium in organic farming silage systems. In Nagy G. & Peto

K (eds.) *Ecology and Grassland*, 17th General Meeting of European Grassland Federation, Debrecen, Hungary, 289-292.